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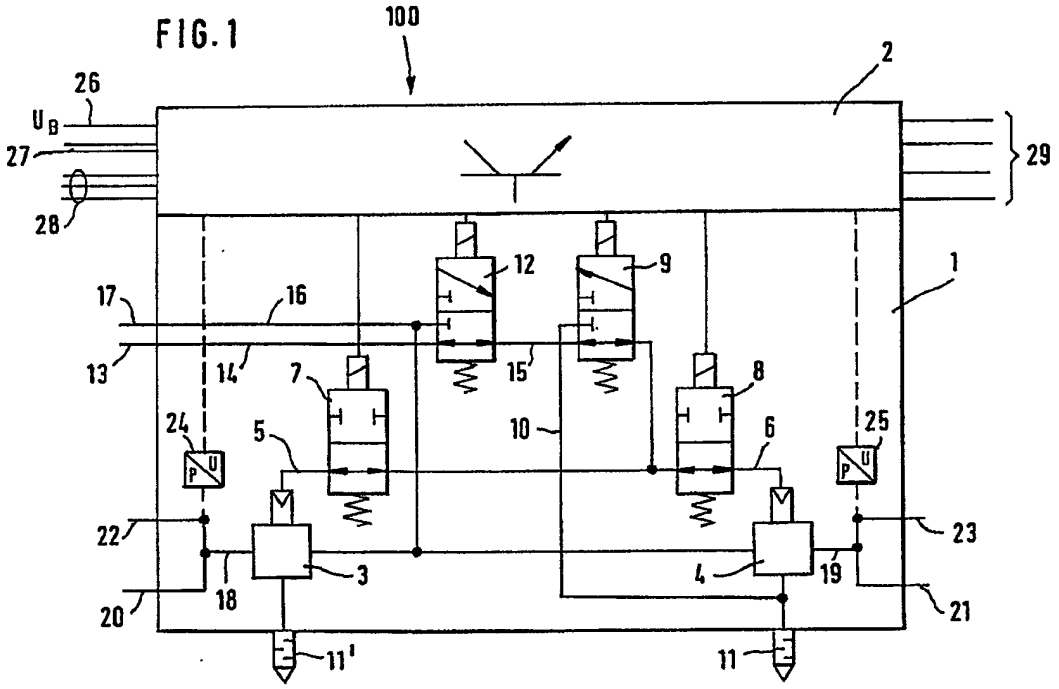
(54) Pressure-regulator modules for braking systems

(57) A pressure-regulator module (100) for an electronically controlled compressed air braking system, comprises a valve unit (1) having two relay valves (3, 4) and only one electronic unit (2). The relay valves control flow of compressed air from an inlet (17) to wheel brake cylinders via outlets (20 - 23), and are controlled by air from inlet (13) via valves (7 - 9, 12) controlled by the electronic unit (2).

FIG.1



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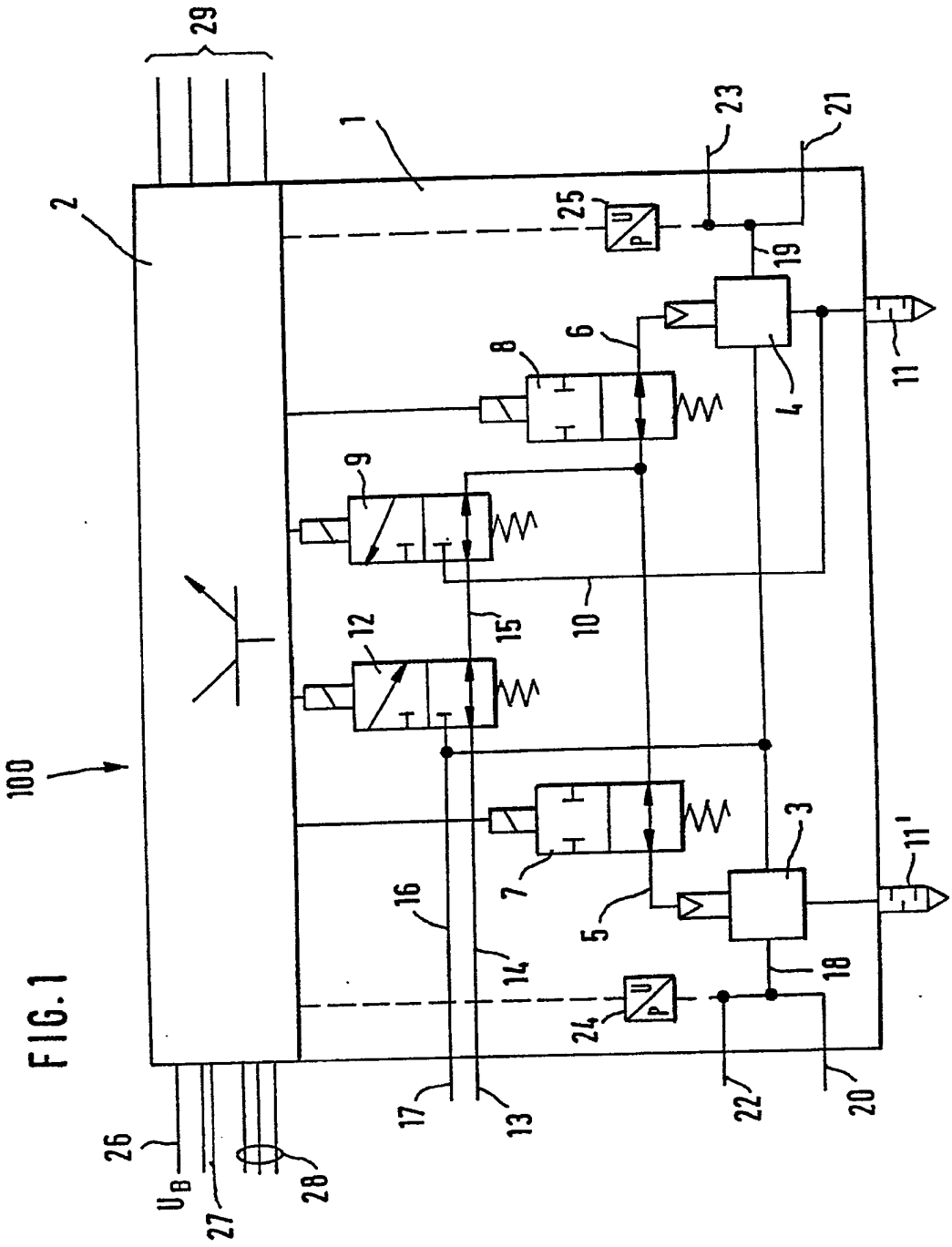

29
1
2
23
21
25
19
6
8
4
11
9
10
15
12
100
3
11'
7
5
16
14
18
24
17
13
22
20
26
U_B
27
28

FIG.1

FIG. 2

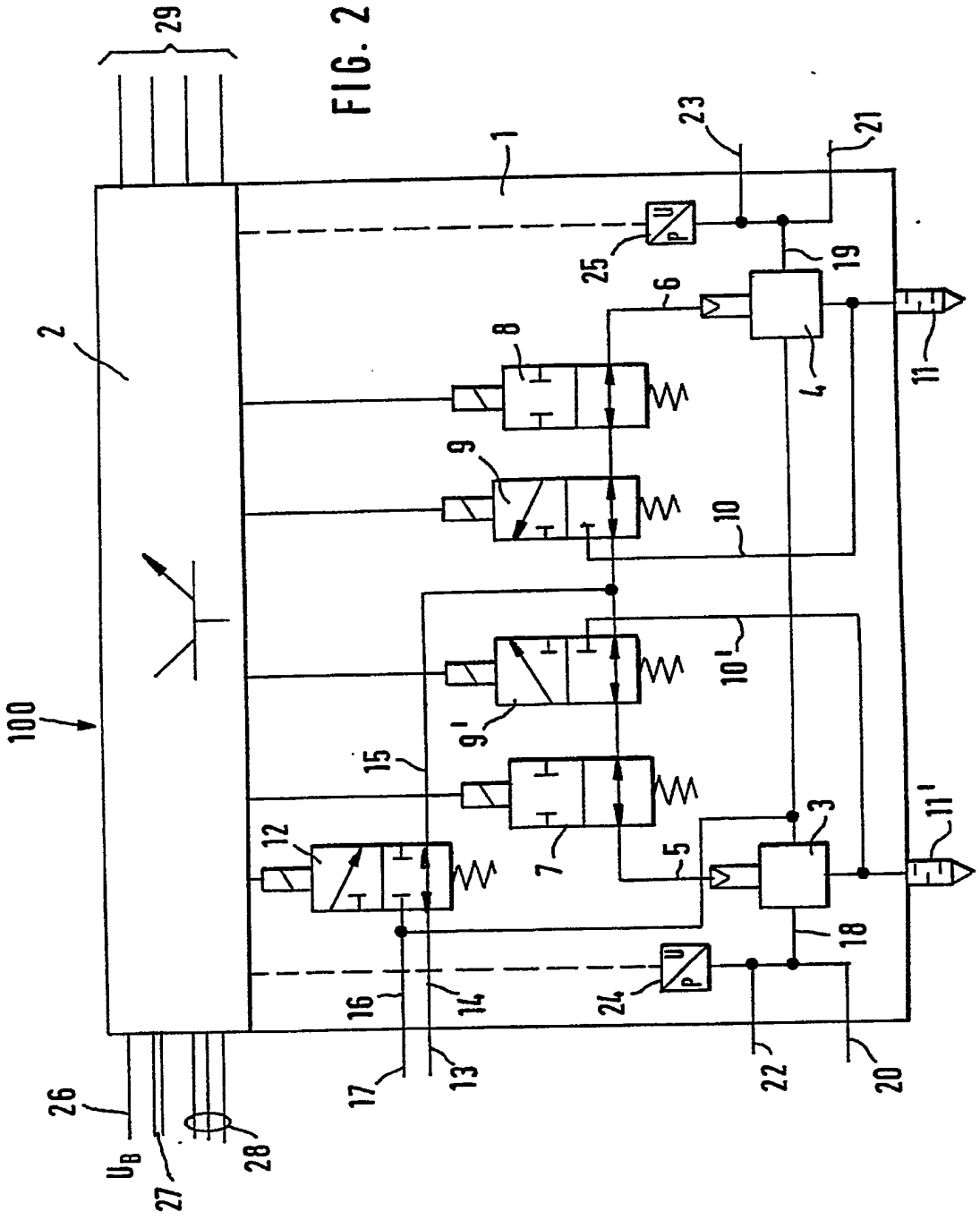

29
1
23
21
25
19
6
11
2
8
4
9
10
100
10'
9'
15
12
7
5
3
11'
18
16
14
24
17
13
22
20
26
U_B
27
28

FIG. 2a

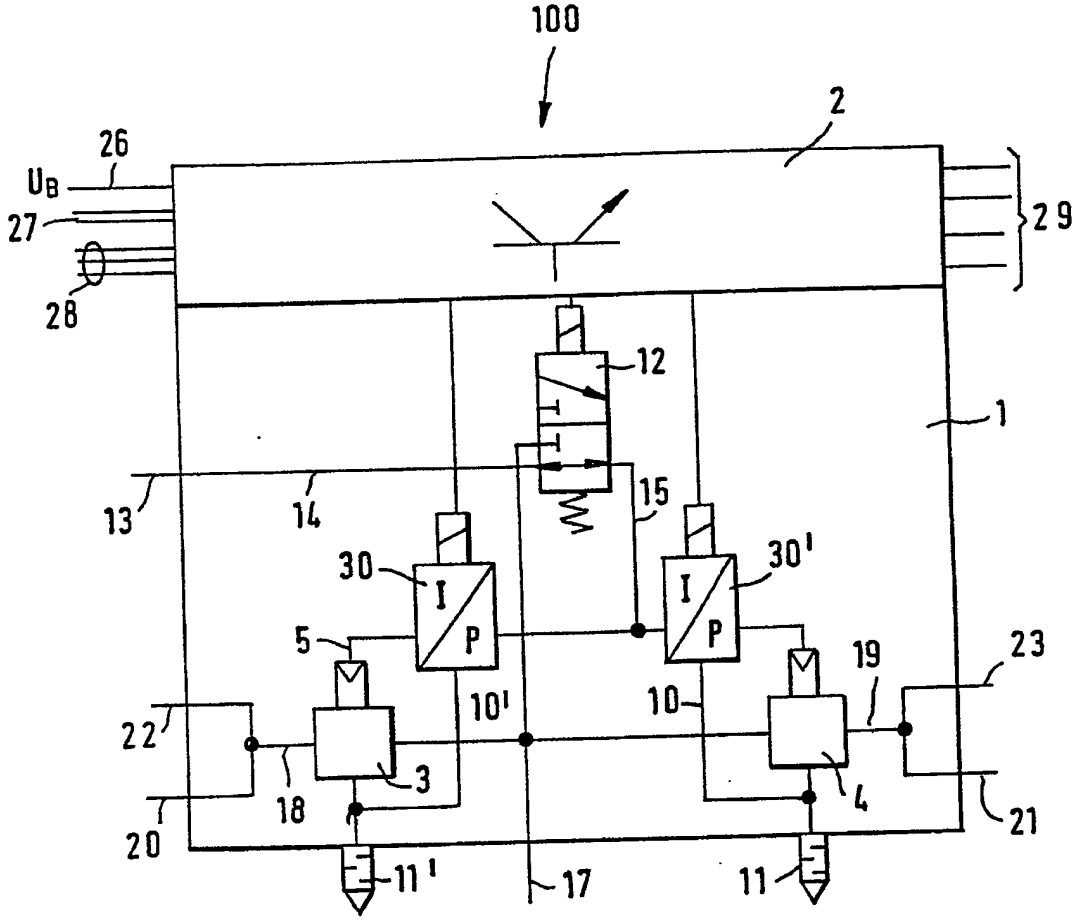
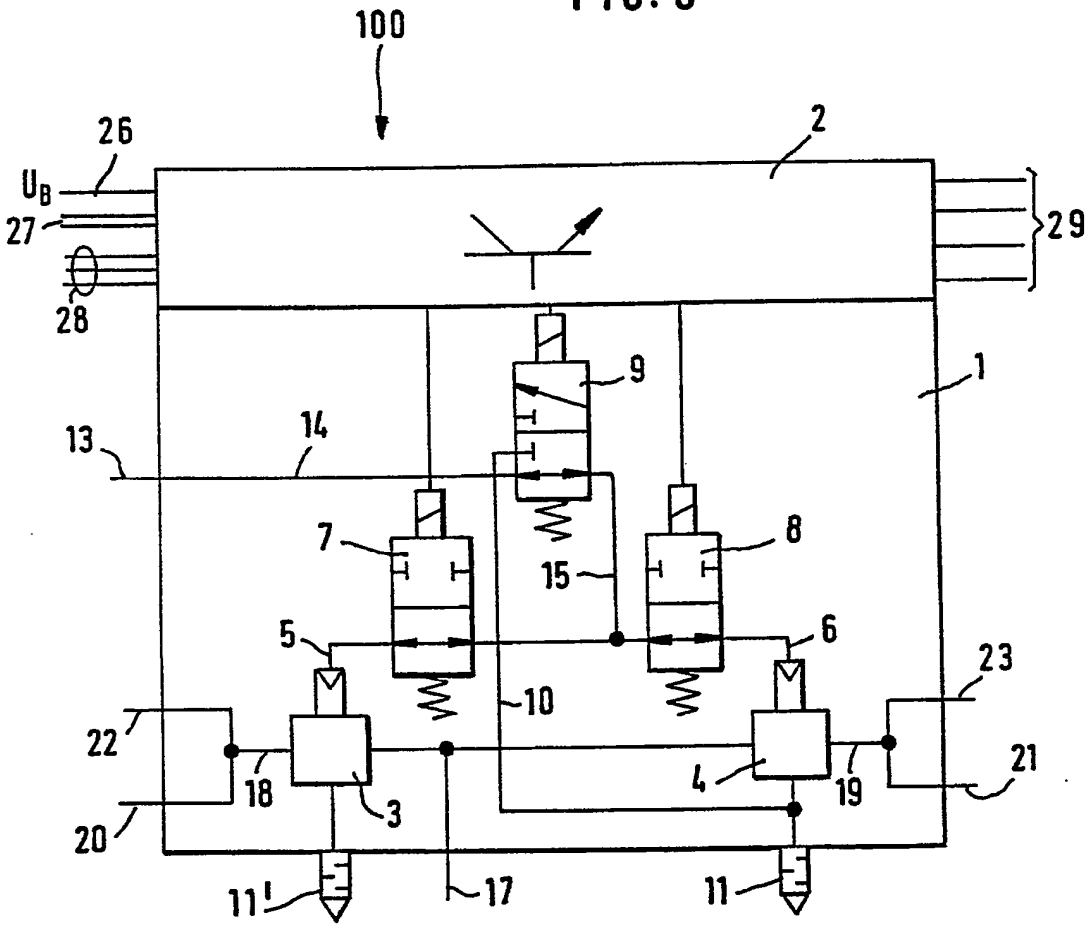

100
2
26
U_B
27
28
29
12
1
13
14
15
30
30'
I
P
5
19
23
22
10'
10
3
4
18
20
21
11'
17
11

FIG. 3



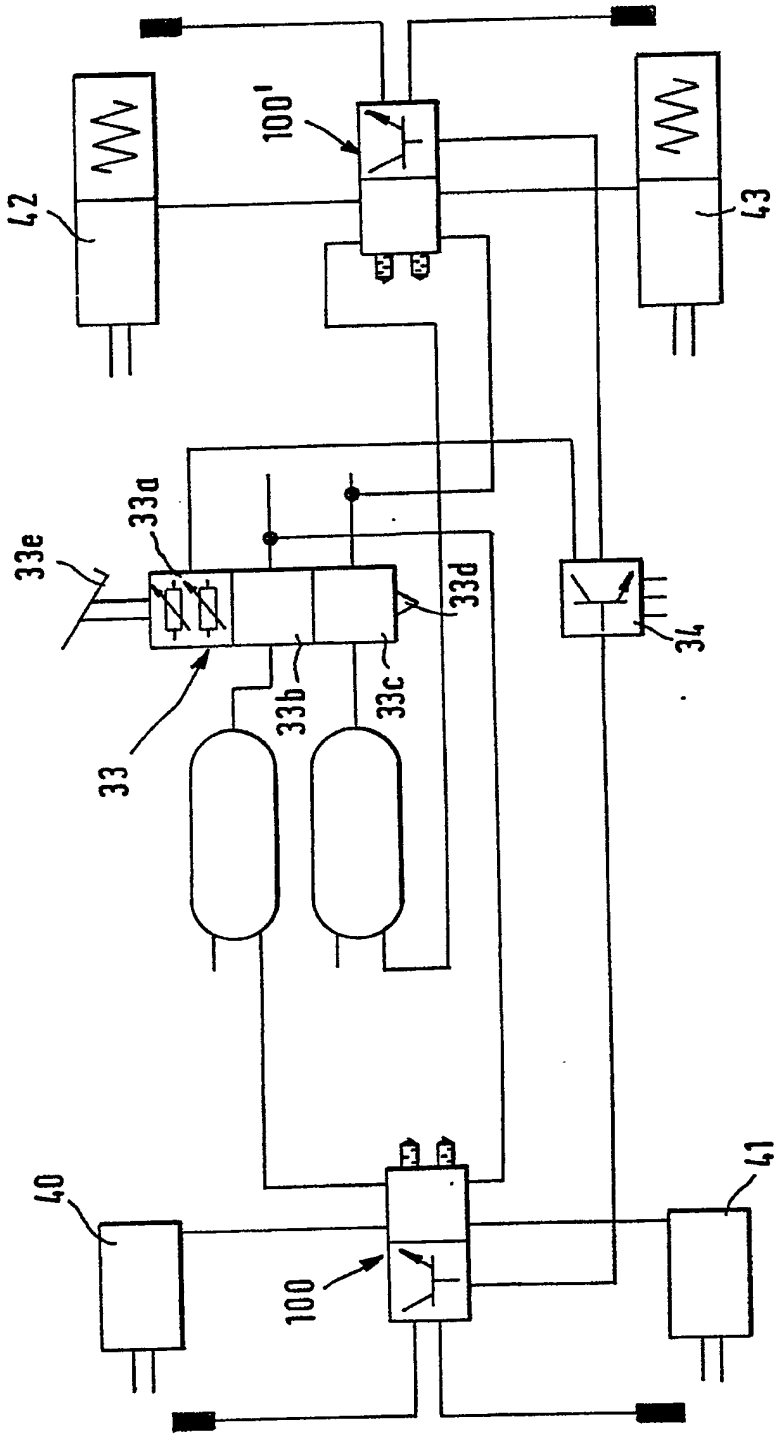
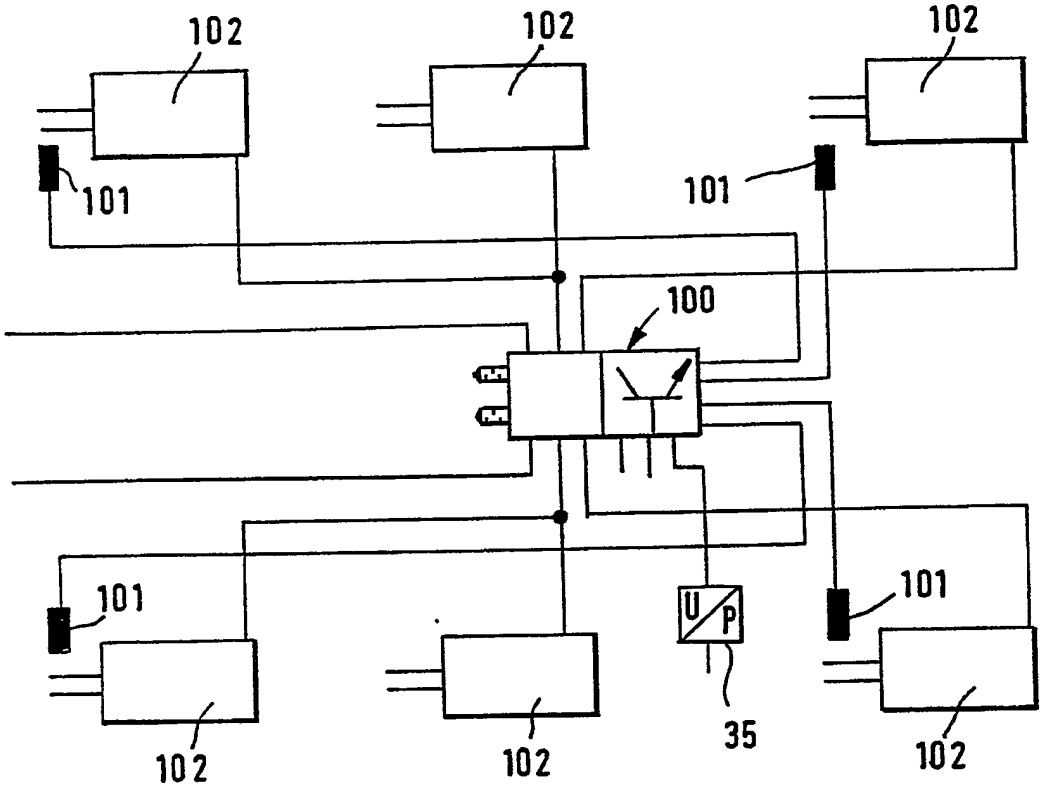


FIG.4

FIG. 5



DESCRIPTION

"PRESSURE-REGULATOR MODULES FOR BRAKING SYSTEMS"

The invention relates to pressure-regulator modules, for compressed air braking systems, and in particular, but not exclusively, to pressure-regulator modules for commercial motor vehicles.

A pressure-regulator module is known from EP-A-0 467 112 which describes an electronic braking system for road vehicles having an electronic system for controlling the braking pressure modulators, the electronic system being divided into a plurality of wheel modules which are allocated to the individual wheels, the wheel modules being provided with at least one micro-computer, and into at least one superior central module provided with a micro-computer. The possibility of combining two wheel modules on one axle to form an axle module is mentioned.

An electronic braking system for road and rail vehicles of the aforementioned type, whose wheel-related regulating units are provided with their own electronic control system and these regulating units being coordinated by way of interfaces based on a centrally disposed electronic system and it being possible to exchange data mutually by way of these interfaces, are in principle suitable to comply with the requirements of a modern electronic braking system.

It has however become evident that the functional advantages which can actually be achieved thereby do not compensate for the additional costs of such a system in comparison to a conventional braking system.

Based on the prior art the object of the invention is to produce a pressure-regulator module which when in use will enable the production costs to be reduced noticeably in comparison to the known wheel-related concept by reducing the number of system components required and will simultaneously improve the security of the system.

In accordance with the present invention there is provided a pressure-regulator module for a compressed air braking system, comprising a solenoid valve for controlling a valve unit, the valve unit having two ducts with a relay valve in each duct and a single electronic unit which serves to control the two relay valves and the braking cylinder of at least one motor vehicle axle, the electronic unit having a micro-computer which can be connected to at least a further electronic system unit for the purpose of exchanging electrical signals.

This has the advantage that it is possible to control the pressure individually or two separate outlets and/or for two separate brake cylinders and/or pairs of brake cylinders with only one electronic

unit. Furthermore, the embodiment of the invention has the possibility of using at least one of the solenoid valves for controlling the pressure at the two outlets of the valve unit.

Preferably, each of the two relay valves of the valve unit is allocated on the input side a respective control solenoid valve and a common three-port, two-position solenoid valve which serves as a venting valve for the purpose of producing an external air connection is connected in advance of the two control solenoid valves on the input side this is particularly advantageous, where the two pressure-regulator ducts are allocated a common change-over valve in the form of a three- port, two-position solenoid valve.

Preferably each of the two relay valves of the valve unit is allocated on the input side a respective control solenoid valve and a respective three-port, two position solenoid valve which serves as a venting valve for the purpose of producing an external air connection is connected in advance of each of the two control solenoid valve on the input side. This has the advantage that in the event of the electrical and/or electronic control system failing, a further change-over valve common to the two pressure-regulator ducts enables the pressure-regulator module to

function as in a conventional pneumatic braking system.

Further advantages of the pressure module in accordance with the invention is that it is possible, with the aid of the pressure module, to achieve an "electronic differential block" without additional valve devices. Furthermore, the pressure-regulator module offers the advantage that even when the electronic braking system is switched off or fails, a fully effective conventional pneumatic braking system is still available.

By way of example only specific embodiments of the invention will know be descibed with reference to the accompanying drawings, in which

Fig. 1 is a schematic view of one embodiment of a 2-duct pressure-regulator module constructed in accordance with the invention;

Fig. 2, 2a and 3 are further embodiments of 2-duct pressure-regulator modules in accordance with the invention;

Fig. 4 is a schematic illustration of a motor vehicle braking system which is constructed as shown in Fig. 1 and 2 and/or 2a using pressure-regulator modules; and

Fig. 5 is a likewise schematic view similar to Fig. 4 of substantial parts of a motor vehicle

braking system constructed using a pressure-regulator module in accordance with the invention.

In detail, Fig. 1 illustrates a pressure-regulator module 100, which according to the invention is a 2-duct pressure-regulator module. The pressure-regulator module 100 comprises a valve unit 1 and an electronic unit 2 which is mechanically and electrically connected directly to the valve unit 1.

The valve unit 1 comprises two separate pressure-regulator ducts each having a separate relay valve 3 and/or 4. The pneumatic control input 5 of the relay valve 3 is controlled by a two-port, two-position solenoid valve 7 individually allocated to the relay valve 3. The pneumatic control input 6 of the relay valve 4 is controlled by a further two-port, two-position solenoid valve 8 individually allocated to the relay valve 4.

A common change-over valve is connected in advance of the two two-port, two-position solenoid valves 7, 8 in the form of a three-port, two-position solenoid valve 9 which is explained further hereinunder and which serves to vent the relay valves 3, 4 and/or the brake cylinder (not illustrated) associated therewith by way of an external air connection 10, 11.

A further three-port, two-position solenoid valve

12 is connected in the form of a change-over valve in advance of the three-port, two-position solenoid valve 9 used for venting. The solenoid valve 12 is likewise allocated in common to the two pressure-regulator ducts. In its spring-actuated starting position illustrated in Fig. 1 and/or in its non-energized condition, the further three-port, two-position solenoid valve 12 connects a connection 13 of the pressure-regulator module 100, where a control pressure is present, by way of lines 14 and 15 and the three-port, two-position solenoid valve 9 as well as each of the two-port, two-position solenoid valves 7, 8 with the control inputs 5, 6 of the relay valves 3 and/or 4. In the energized condition, i.e. in the case of a controlled excitation winding, the further three-port, two-position solenoid valve 12 connects a connection 17 by way of lines 16, 15 to the inlet side of the three-port, two-position solenoid valve 9, so that a reservoir pressure can be provided at the connection 17 by way of the solenoid valves 7, 8 to the pneumatic control inputs 5, 6 of the relay valves 3, 4.

Each of the two relay valves 3, 4 has its own working connection 18 and/or 19 which branches in each case into two connections 20, 22 and/or 21, 23. Each connection 20, 22 and/or 21, 23 leads in each case to a brake cylinder (not illustrated) of a motor vehicle

wheel. As indicated by the broken line, for the purpose of controlling the working connections 18, 19 a pressure sensor 24 and 25 can be connected optionally to the connections 18, 19 respectively, wherein the two pressure sensors 24, 25 are connected electrically in each case direct to the electronic unit 12.

The electronic unit 2 comprises at least one micro-computer, which has its own intelligence, as well as further, not explained in more detail, electronic and/or electrical components which are provided with a supply voltage U_B by way of a connection 26 and are in the position to process incoming analogue and digital signals and to exchange information by way of at least one interface with at least a further electronic system unit as well as output control commands and signals to at least one further electronic or electrical unit, in particular to the valves 7, 8, 9, 12 of the valve unit 1 in accordance with Fig. 1 and/or to the valves of the modified valve units as shown in Fig. 2, 2a and 3.

For this purpose, the electronic unit 2 has available by way of the interface connections 27, connections 28 for the purpose of transmitting and receiving analogue and/or digital signals and connections 29 corresponding to the number of motor

vehicle wheels provided with sensors for sensor input signals reproducing the rotational behaviour of the wheel.

The 2-duct pressure-regulator module 100 as shown in Fig. 1 can be used in a different manner both in an electronic braking system as well as in a conventional braking system and functions as follows:

In the case of a non-actuated braking value sensor 33 (cf. Fig. 4) - a braking value sensor of this type is described as an example in a previous non-published application of the Applicant (German Patent Application P 41 41 995.2) - all the magnetically actuated valve units 7, 8, 9, 12 are located in the condition illustrated in Fig. 1, i.e. in their spring-actuated starting position. As soon as the pedal of the braking valve and/or of the braking value sensor 33 is actuated, the instantaneous position of the pedal is relayed as an electrical signal produced for example with the aid of a potentiometer if necessary by way of an electronic system unit - which in the case of the embodiment as shown in Fig. 4 is a central control unit 34 - to the interface connections 27 of the pressure-regulator module 100. The electronic unit 2 subsequently produces corresponding electrical signals which in the case of the first measurable movement of the pedal of

the braking value sensor 33 causes the three-port, two-position solenoid valve 12 to be immediately changed over into its working position. Moreover, corresponding output signals for the two two-port, two-position solenoid valves 7 and 8 are produced by the electronic unit 2 in dependence upon the size of the output signals of the braking value sensor 33 and these solenoid valves can in the case of the embodiment as shown in Fig. 1 for example be so-called high pulse valves and control the pneumatic control inputs 5, 6 of the two relay valves 3, 4 accordingly, so that the brake cylinder pressure at the working connections 18, 19 is "highly pulsed" corresponding to the position of the pedal of the braking value sensor 33. If at the same time the pressure at the working connections 18, 19 is controlled by virtue of the pressure sensor 24 and/or 25 illustrated by the broken line in Fig. 1, a closed pressure control loop for controlling the braking cylinder pressure is produced.

A reduction in pressure - the release of the brakes - follows when the pedal of the braking value sensor 33 for the two pressure ducts is released by virtue of controlling the three-port, two-position solenoid valve 9 by the electronic unit 2 in such a way that the solenoid valve 9 is moved out of its spring-actuated starting position into its

magnetically operated working position, whilst simultaneously the external air connection 10, 11 is connected by way of the two-port, two-position solenoid valves 7, 8 located at this point in time in their starting position to the pneumatic control inputs 5, 6 of the relay valves 3 and/or 4, causing the control chamber of the relay valves 3, 4 to vent, as a result of which the braking cylinder (not illustrated) connected in each case is vented by way of the reaction chambers of the relay valves 3, 4.

Also for the case that the braking system functions in the ABS (anti-skid control operation) or in the ASR (drive-slip control operation) the pressure is reduced by way of the three-port, two-position solenoid valve 9, whilst the holding function and the pressure-build up function are again achieved by way of the two two-port, two-position valves 7, 8. It is at the same time readily possible by controlling these two two-port, two-position solenoid valves 7, 8 in a de-phased manner both when building up the pressure and also when reducing the pressure to produce different braking pressures in the two controlled pressure ducts.

In the case of the embodiment of the valve unit 1 illustrated in Fig. 1, it is however not possible to build up the braking pressure in one pressure duct

i.e. the pressure at the relevant working connection 18 and/or 19 for one pressure duct and simultaneously to reduce the braking pressure for the other pressure duct. If it is desired and/or required that the braking system functions in this way, then the embodiment of the invention as shown in Fig. 2 has the possibility, moreover whilst maintaining the identical structure of the valve unit 1, of additionally providing a further three-port, two-position solenoid valve 9' as a venting valve and of venting the relay valve 3 by way of this separate external air connection 10', 11'. In the case of the valve unit 1 of the embodiment as shown in Fig. 2, a dedicated three-port, two-position 9, 9' solenoid valve in the form of a venting valve and a dedicated external air connection 10, 10', 11, 11' is provided for each relay valve 3, 4.

A further variant of the valve unit 1 which likewise offers the possibility of simultaneously building up the braking and/or working pressure in one pressure duct and reducing this pressure in the other pressure duct, is illustrated in Fig. 2a, in to which the two three-port, two-position solenoid valves 9, 9' are replaced in each case by a proportional valve 30, 30', wherein the valve unit 1 is moreover designed like the valve unit 1 in Fig. 2.

In the case of the variant as shown in Fig. 2a, the relay valves 3, 4 are controlled therefore in each case by way of a proportional valve 30, 30', which as a pilot valve allocates a control pressure to the relay valves 3, 4 allocated in each case and this control pressure is directly proportional to a predetermined control current produced by the electronic unit 2.

In the case of the pressure-regulator module 100 illustrated in Fig. 3 the valve unit 1, is constructed like the valve unit 1 of the embodiment as shown in Fig. 1, but does not comprise the further three-port, two-position solenoid valve 12. In the case of this variant the control pressure from the connection 13 is only ever available on the inlet side of the three-port, two-position solenoid valve 9, whilst the reservoir pressure from the connection 17 is constantly available directly at the two relay valves 3, 4, as is the case with the variants as shown in Figs. 1, 2 and 2a.

The embodiment as shown in Fig. 3 is advantageously used for conventionally braked trailer vehicles, which only require an ABS function.

For vehicles having driven axles, an ASR function (drive-slip control operation) is however frequently necessary in addition to the ABS function.

Irrespective of the fact whether this driven axle is braked in a conventional or electronic manner, it is possible for such a ASR function to be achieved in the most simplest manner with the valve unit 1 in accordance with Fig. 1 with the aid of the three-port, two-position solenoid valve 12. As soon as the electronic unit 1 recognizes during the running operation different wheel rotational speeds, at the driven axle by way of a rotational speed sensor and it not being possible to trace these different wheel rotational speeds to a difference in wheel velocities caused by driving around a curve, then this is interpreted as an undesired slip, upon which the electronic unit 2 changes over the three-port, two-position solenoid valve 12 and by way of the corresponding two-port, two-position solenoid valves 7 and/or 8 increases the braking pressure for the faster rotating wheel until the wheel velocity and/or rotational speed of the two driven wheels are almost identical. At the same time, the build up of a corresponding braking pressure for the brake cylinder of the slower rotating wheel is prevented by virtue of blocking the two-port, two-position solenoid valves 7 and/or 8 allocated to this wheel; the corresponding two-port, two-position solenoid valve 7 and/or 8 is therefore not pulsed by the electronic unit 2, but

rather controlled in such a way that the supply of compressed air to the pneumatic control input 5 and/or 6 of the relevant relay valve 3 and/or 4 is prevented. The solenoid valve 12 is decisive in this respect for the drive-slip control operation and/or for achieving an electronic differential block because when the driven wheels rotate, in particular during start-up, the braking value sensor 33 is normally not actuated and consequently control pressure is not available at the connection 13.

If in the case of a failure, it is not possible to electrically control the three-port, two-position solenoid valve 12, i.e. to switch it on, it is still possible despite this to achieve the full braking effect (back-up function) by way of the line connections 13, 14, 15 which are open in the case of a non-actuated valve. In addition, the full ABS function of the braking system is also maintained in this case.

Fig. 4 illustrates the use of two pressure-regulator modules 100, 100' in accordance with the invention in a complete braking system. It is evident that in addition to its electrical part 33a the braking value sensor 33 comprises two pneumatic parts 33b, 33c and a pressure relief point 33d. The two pneumatic parts 33b, 33c enable the brake cylinders

40, 41, 42, 43 for the four wheels of the motor vehicle to be controlled pneumatically in the conventional manner. The electrical part 33a of the braking value sensor 33 supplies electrical signals which correspond to the position of the pedal 33e to a central control unit 34 which controls the two pressure-regulator modules 100, 100' by way of corresponding bus lines. In the case of the braking system functioning as an electronic braking system these two pressure-regulator modules assume the control of the allocated brake cylinders 4, 41, 42, 43 in the manner as described above.

Fig. 5 illustrates the use of a pressure-regulator module 100 as shown in Fig. 3 for a three-axle trailer vehicle having a conventional braking system.

With respect to the above mentioned function of the pressure-regulator module 100 as shown in Fig. 3, it is possible in the case of the application under consideration to have only one ABS function. The various solenoid valves 7, 8, 9 of the valve unit 1 of the pressure-regulating module 100 is controlled in the manner described above. At the same time, four wheel sensors in the form of rotational speed sensors 101 are connected in to the pressure-regulator module 100 and the output signals of these rotational speed

sensors are processed individually by the pressure-regulator module 100, for example, in such a way that by virtue of the rotational speed signals of the respective two wheels, which are preferably disposed on the side, an individual pressure control is achieved for the relevant braking cylinder 102, in particular according to the principle that the rotational speed of the slower rotating wheel is determined by the function. An additional central electronic unit and/or in general, a further electronic system unit is not necessary in this case.

It is not necessary to have an additional central electronic unit even in the case of an electronic braking system in a trailer vehicle apart from the case of the variants of a pressure-regulator module in accordance with the invention as shown in Figs. 1 and 2, since the two-duct pressure-regulator module can receive the information from the towing vehicle direct by way of its own interface (if necessary a plurality of interfaces) and can process them internally. Further signal values, such as for example the output signals of a load value sensor 35 can also be received and processed in order to produce the braking force suitable for individual cases.

It is clear from the aforementioned description that in comparison to the prior art considerable

advantages can be achieved with the pressure-regulator module in accordance with the invention. First of all one of these advantages exists in the fact that a solenoid valve - for example in the case of the embodiment as shown in Fig. 2 - or two solenoid valves - in the case of the embodiment as shown in Fig. 1 - can be omitted. Above all, when using a pressure-regulator module in accordance with the invention, the advantage is produced that, in comparison to the prior art according to EP-A-O 467 112 A2, it is possible to omit almost completely one wheel module electronic unit. In addition, considerable savings can be made in the electrical and pneumatic lines and line connections, such as plug components, fittings and the like. Finally, in accordance with the invention a greater degree of safety is produced, since less sensitive components and connecting elements are used.

CLAIMS

1. A pressure-regulator module for a compressed air braking system, comprising a solenoid valve for controlling a valve unit, the valve unit having two ducts with a relay valve in each duct and a single electronic unit which serves to control the two relay valves and the braking cylinder of at least one motor vehicle axle, the electronic unit having a micro-computer which can be connected to at least a further electronic system unit for the purpose of exchanging electrical signals.

2. A pressure-regulator module according to claim 1, wherein each of the two relay valves of the valve unit is allocated on the input side a respective control solenoid valve and a common three-port, two-position solenoid valve which serves as a venting valve for the purpose of producing an external air connection is connected in advance of the two control solenoid valves on the input side.

3. Pressure-regulator module according to claim 1, wherein each of the two relay valves of the valve unit is allocated on the input side a respective control solenoid valve and a respective three-port, two position solenoid valve which serves as a venting valve for the purpose of producing an external air connection is connected in advance of each of the two

control solenoid valves on the input side.

4. Pressure-regulator module according to claim 1, wherein each relay valve can be controlled by virtue of a proportional valve.

5. Pressure-regulator module according to claim 2,3 4, wherein a further three-port, two position solenoid valve supplys the control solenoid valves of the valve unit provided upstream of the further solenoid valve with pneumatic pressure in a spring-loaded starting position, a control line is opened and this control line serves the conventional pneumatic braking operation and a control pressure can be transmitted in the control line or in a solenoid-actuated working position, a line which is charged with a resevoir pressure can be opened.

6. Pressure-regulator module according to one of claims 1 to 5 wherein the pressure at each of the working connections of the relay valves can be detected with the aid of a pressures sensor electrically connected to the electronic unit.

7. Pressure-regulator module according to one of claims 1 to 6, wherein the electronic unit is formed in such a way that up to four wheel velocities can be individually evaluated with the aid of the electronic unit for the purpose of controlling the pressure at the two separate working connections of the relay

valves.

8. Pressure-regulator module according to one of claims 1 to 7, wherein the electronic unit is formed in such a way that the output signals of further external signal value sensors can be evaluated with the aid of the electronic unit for the purpose of controllling or regulating the pressures at the two separate working connections of the relay valves.

9. A pressure-regulator module constructed and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, the accompnaying drawings.

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